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ABSTRACT

This guide for developing standard operating job procedures for wastewater treatment facilities is devoted to the activated sludge aeration and sedimentation process. This process is for conversion of nonsettleable and nonfloatable materials in wastewater to settleable, floculated biological groups and separation of the settleable solids from the water. The guide gives step-by-step pre-start up, start-up, operating, and shut-down instructions along with a general description of the equipment used in the process and some theoretical material. (BB)

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SOJP NO 5

ACTIVATED SLUDGE-AERATION AND SEDIMENTATION

A GUIDE FOR THE DEVELOPMENT OF

STANDARD OPERATING JOB PROCEDURES

FOR WASTE WATER TREATMENT PLANT UNIT OPERATIONS

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
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A GUIDE FOR DEVELOPING

STANDARD OPERATING JOB PROCEDURES

FOR THE

ACTIVATED SLUDGE - AERATION & SEDIMENTATION PROCESS

WASTEWATER TREATMENT FACILITY

SOJP NO 5

Developed by Charles County Community College under
a grant with the

Manpower and Training Staff
Office of Water Programs Operations
Environmental Protection Agency

Standard Operating Job Procedures for the Activated Sludge - Aeration & Sedimentation

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PAGE NO 1

Process Activated Sludge - Aeration & Sedimentation

1. Operation Objectives

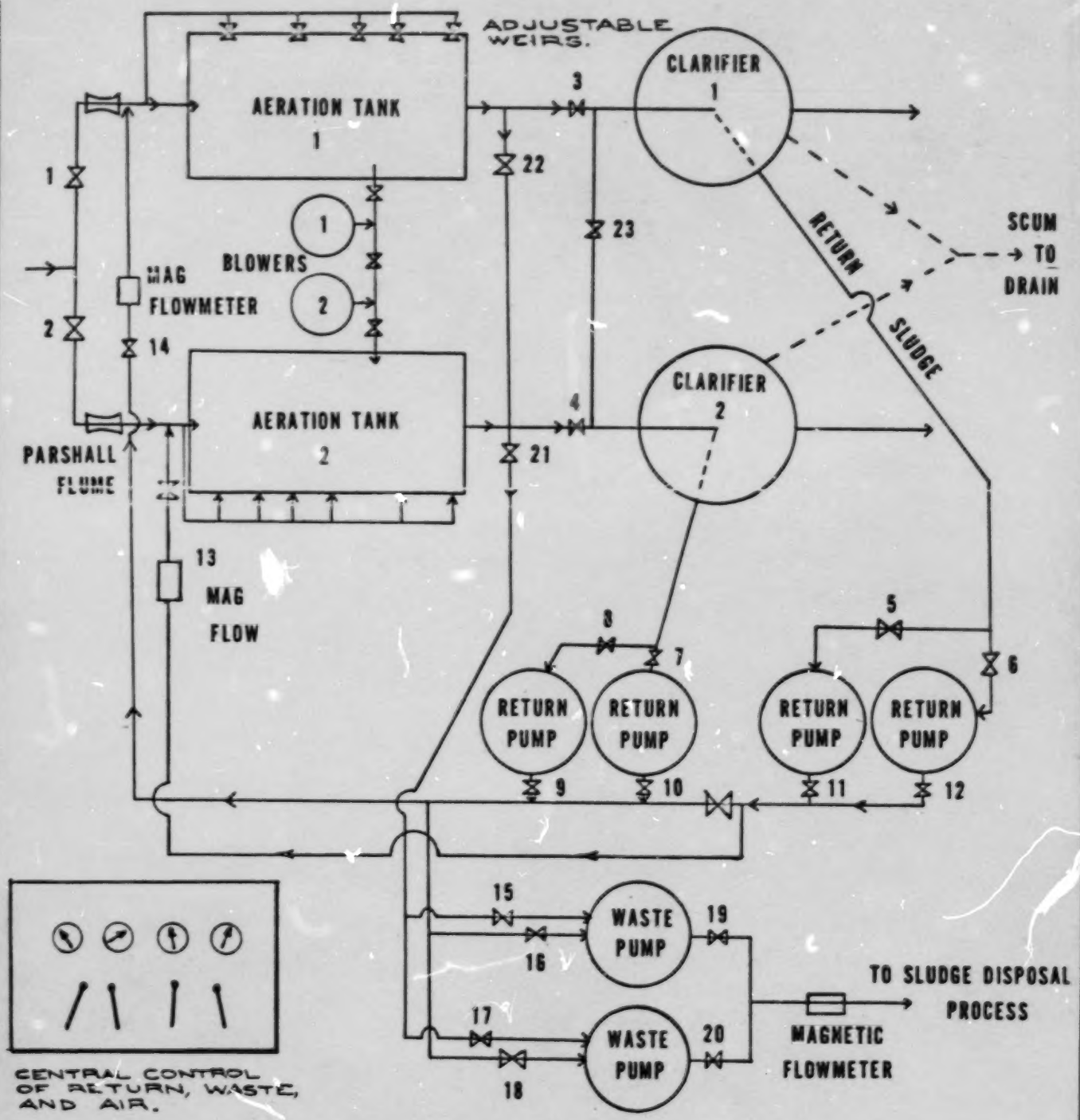
2. Brief Description of Process

1. Conversion of nonsettleable and nonfloatable materials in wastewater to settleable, flocculated biological groups and separation of the settleable solids from the water.

2. Wastewater enters the aeration unit where air is applied to mix the waste materials and biological organisms and to supply the organisms with oxygen to promote their growth. The organisms feed on the waste material converting it to water, carbon dioxide and more organisms. As the material is consumed or entrapped by the organisms, a floc, or grouping of organisms is formed. The water and floc flow to settling basins where quiet conditions allow the floc to separate from the water. The water flows from the surface of the tank to further processes or to a receiving stream and the settled organisms are returned to the aeration tank once again to be mixed with waste materials. The concentration of the organisms is controlled by wasting excess solids to disposal operations.

Process Activated Sludge - Aeration & Sedimentation

Flow Sheet



Process ACTIVATED SLUDGE - AERATION & SEDIMENTATION

General Description of Equipment Used in the Process

Flow Measurement

Influent - Parshall Flume - Bubbler Tube Level Sensor
Return Activated Sludge - Magnetic Flow Meter
Waste Activated Sludge - Magnetic Flow Meter
Air Flow, Orifice Plates, Differential Tubes, Totalizer Integrators

Air Application

Common Header, Swing Type Diffuser Arms
Sparger Diffuser - Coarse Bubble - 3/8" Orifice
Centrifugal Blower, Constant Speed Motor, Manual Valve Control for flow with Automatic Back Pressure Control
Two Aeration Tanks - Width equal to Depth

Sedimentation

Center Feed Clarifiers with Skimming Device, Hydraulic Suction type Sludge Collectors, Notch Overflow Weirs

Sludge Pumping

Centrifugal, Varispeed Pump, Electric Drive

Control and Metering

Central Control Panel for Return Activated Sludge, Wasting and Blower Control

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
A. PRE-START UP PROCEDURES			
1. Safety Inspection	1. Check valves 1, 2, 3, 4, 21, 22, 23, 13, 14.	1. Closed and tagged.	XII-1, V-1 IV-1
	2. Check drive power to clarifier sweeps.	1. Closed, locked and tagged.	XII-2, V-2 IV-1
2. Aeration Tank Inspection	1. Check structure.	1. Free of debris, water stops at joints not leaking.	V-3
	2. Check drain valves.	1. Closed, operate freely.	V-4
	3. Check mud valves.	1. Closed, move freely.	V-5
	4. Check aeration tank feed channels.	1. Free of debris.	
	5. Check antifoam sprays.	1. Clean.	V-6, VII-6
	6. Check aeration spargers.	1. Clean. 2. Desired distribution.	V-7 VII-6
	7. Check aeration swing arms.	1. O-rings seated and lubricated.	V-8
3. Clarifier Inspection	1. Check tank structure.	1. Free of debris. 2. Baffle bolts tight. 3. Weirs solidly attached and level. 4. Catwalk supports secure. 5. Gratings bolted down.	V-9 V-10 V-11 XII-3,V-12

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	2. Clarifier feed channels	1. Free of debris	
	3. Check drain valves and mud valves	1. Closed and operate freely	V-13
	4. Check suction arm supports	1. Connected solidly	V-14
		2. Adjusted so arms are level	V-15
		3. Proper clearance from floor (about 1")	V-15
	5. Check center well	1. Free of debris	V-16
		2. Ports open	V-16
	6. Check scum removal valves	1. Closed and operate freely	V-17
4. Equipment Inspection	1. Check aeration, return sludge and waste sludge piping and valves	1. No pitting	V-18
		2. Couplings tight	V-19
		3. All valves operate freely	V-19
	2. Inspect return sludge and waste activated sludge pumps	1. Couplings solid and aligned	V-20
		2. Seal water available and adjusted	V-21
		3. Lubrication as per mfg. specifications	V-22
		4. Power to drive motors	V-23
	3. Inspect clarifier sweep	1. Power to drive motor	V-24
		2. Motor securely mounted and aligned	V-25
		3. Oil level at mark	V-26
		4. Shear pin properly placed	V-27
		5. Shear faces lubricated	V-28
		6. Gears greased	V-29
	4. Inspect magnetic flow meters	1. Power off	V-30
		2. Meter on - indicates zero	V-31

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	5. Inspect aeration blowers	1. Intake filters clean	V-32
		2. All alarms clear	V-33
		3. Oil temperature at mfg. specs for startup	V-34
		4. Cooling water valves open	V-35
		5. Inlet and discharge valves open to excess pressure blow-off limits	V-36

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
B. START-UP PROCEDURE			I-1
1. Fill Tanks	1. Clear tanks of all personnel and equipment	1. To prevent injury and equipment damage	XII-4 XII-7
	2. Open valves 1, 3, 5, 6	1. To allow flow into tank #1 very slowly	V-37
	3. Check valves 22, 23, 16, 18	1. Closed to prevent flow from draining through waste pumps	V-38
	4. Start aeration blower 1	1. When diffusers are covered 2. Turn on power to drive motor 3. Adjust back pressure control and put on automatic control 4. Adjust blower flow control to 50% of rated output	V-39 V-40 XI-1 V-41
	5. Start clarifier suction arm drive	1. When water just covers suction arms	V-42
	6. Observe suction arm	1. Through at least one complete revolution	
	7. Turn on instrument air to Parshall Flume bubble tube	1. Set air flow rate per plant manual 2. To start flow measurement and recording	V-43 XI-1
	8. Start return sludge pumps	1. When clarifier is full 2. Open valves 5, 6, 11, 12, 13, 14 3. Adjust return pumping to 50% of influent flow	V-43 V-43 V-43, VII-2 VII-7

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
C. ROUTINE OPERATION			
1. Observation	1. Observe surface of aeration tank once every 2 hours	1. Good mixing, minimum of dead spots 2. Color-red brown to brown 3. Odor-like earth 4. Foam, color and amount 5. Foam control sprays on	VI-1 VI-2 VI-3 VI-4
	2. Observe surface of clarifiers once every 2 hours	1. Minimum of scum 2. Minimum rising sludge 3. Minimum suspended materials	VII-1,VI-5 VI-6 VI-7
	3. Check clarifier sludge blanket and record once every 2 hours	1. Level between 1/4-1/2 tank depth	VI-8
	4. Observe flow over clarifier weirs	1. Even flow 2. Weirs clean	VI-9 VI-9
	5. Observe return sludge flow	1. Color brown to red-brown 2. Odor-earthy 3. Even smooth flow	VI-2 VI-3 III-1
2. Equipment Checking (every 4 hrs)	1. Check blower and record readings	1. Suction gauge near zero 2. Oil temperature per mfg. specs. 3. Oil pressure per mfg. specs. 4. Cooling water flow at set point 5. Ammeters per mfg. spec. 6. Phase angle indicator greater than p.85 7. Bearing temperature per mfg. specs. 8. Vibration monitor within specs.	V-44 V-45 V-45 V-45 V-46 V-47 V-48 V-49

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	2. Check return sludge pumps and record readings	1. Bearing temperature per mfg. specs. 2. Motor temperature per mfg. specs. 3. Coupling quiet and smooth 4. Record pump output from magnetic flow meter 5. Check seal water flow 6. Check discharge pressure	V-48 V-50 V-51 V-52,XIII-1 V-52
	3. Check waste sludge pump and record readings	1. Same as return sludge pump check	V-52, V-51 V-48, V-50 XIII-1
	4. Check Parshall Flume	1. Clean, no obstructions 2. Purge bubbler tume 3. Record reading	XI-1, VI-8 XI-1 XIII-1
3. Equipment Adjustments	1. Adjust aeration blower output	1. As required to maintain > 1.0 and < 3.0 mg/l D.O. throughout aeration tank (see Process Control) 2. Adjust manual control slowly	VII-4
	2. Adjust return sludge flow rate	1. As required by process demand (See Process Control)	
	3. Adjust waste sludge pumping rate	1. As required by process demand (See Process Control)	
	NOTE: RECORD ALL OBSERVATIONS AND READINGS IN C ABOVE		XIII-1
4. Housekeeping	1. Clean effluent weirs	1. Daily 2. To maintain even overflow	V-53,XII-5
	2. Clean clarifier center	1. Daily	

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		2. To prevent odors and maintain free flow	V-53,XII-5
	3. Clean aeration tank walls	1. At water level 2. Once every 2 weeks 3. To prevent odors	V-53,XII-5
	4. Clean distribution channels and Parshall Flume	1. Every other day 2. To maintain accurate flow measurement 3. To prevent odors	V-53, XII-5
	5. Clean clarifier walls	1. At water level 2. Twice a week 3. To remove algae and grease	V-53,XII-5
	6. Clean all pumps, motors and blowers	1. Daily 2. While shut down 3. To maintain cleanliness and increase equipment life	V-54 XII-6
	7. Clean control panel(s)	1. Daily 2. To maintain appearance and operation 3. To prevent accidental starts or stops	V-55 XII-7
	8. Clean structures and walkways	1. To prevent falls 2. Always keep clean and free of debris, hoses and tools	XII-8
	9. Clean piping and valves	1. To maintain function and top appearance	V-56

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
C-I PROCESS CONTROL			
1. Sampling	1. Collect a flow paced composite sample of influent wastewater	1. Daily 2. Refrigerate at 4°C after each sampling 3. Analyze for BOD, suspended solids, total phosphorus and COD and record	X-1
	2. Collect a flow paced composite sample of mixed liquor	1. Daily 2. Refrigerate at 4°C after each sampling 3. Analyze for suspended and volatile solids, and record	X-1
	3. Collect a flow paced composite sample of return activated sludge	1. Same as for mixed liquor	X-1
	4. Collect a flow paced composite sample of the clarifier over-flow	1. Daily 2. Refrigerate at 4°C after each sample 3. Analyze for BOD, COD, turbidity, suspended solids and total phosphorus, and record	X-1
	5. Collect a grab sample of the influent	1. Daily 2. Determine and record Ammonia-N	X-2
	6. Collect a grab sample of the effluent	1. Daily 2. Determine and record Nitrate-N	X-2
2. Sampling for Control	1. Grab a sample of mixed liquor	1. As needed for control purposes-may be once/hour or once/4 hours 2. Perform settling rate test, 60 minutes in 5" drain settleometer	X-3 X-4

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
		3. Perform 15-minute centrifuge test using API centrifuge tubes in a clinical centrifuge at 2000 rpm	X-5
		4. Examine microscopically for compact floc and the presence of a variety of protozoa	III-1
		5. Determine D.O. immediately	X-6
	2. Grab a sample of return activated sludge	1. As needed-same as mixed liquor 2. Perform a 15-minute centrifuge test Record results	X-3 X-5
	3. Grab a sample of the clarifier overflow	1. As needed 2. Perform turbidity test	X-3
	4. Determine sludge blanket depth in clarifier	1. At least once/8 hour shift 2. Record 3. Use air lift or photoelectric probe	VI-8
	5. Record physical observations during tests	1. As performed 2. Straggler floc, color, odor, etc.	X-1
	6. Read all flow meters at sampling times	1. Record	XIII-1
3. Analysis of Samples for Control	1. Perform settleometer test	1. Use a 2 liter settleometer or 2 liter graduated beaker	X-4
		2. Get sample from well mixed section toward end of aerator and put immediately into settleometer	X-4
		3. Observe carefully first 15 minutes	X-4
		4. Read and record volume occupied by sludge every 5 minutes for first 30 minutes and	X-4

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
		every 10 minutes for last 30 minutes	
		5. Plot volume versus time	II-1
	2. Perform centrifuge test	1. Use API centrifuge tubes	X-5
		2. Use clinical centrifuge to obtain level sludge surface	X-5
		3. Pour sample into tube, spin 15 minutes at 2000 rpm	X-5
		4. Record sludge volume	X-5, XIII-1
	3. Perform turbidity test	1. Use photoelectric turbidimeter readout in JTU on effluent grab sample. Stir effluent sample and run an initial turbidity, then allow the sample to settle for one hour and run a second turbidity on the supernatant liquor that is free from any floating scum or settled solids.	X-2
	4. Perform dissolved oxygen test	1. At least once per 8 hour shift. More often if necessary.	X-6
		2. Use a battery operated D.O. probe preferably. If not available, use Standard Methods Winkler test.	X-6
4. Interpretation of Laboratory Results	1. Examine plot of settling	1. Normal sludge will settle at a fairly rapid rate during the first 10 minutes, then the rate will drop off rapidly and at 60 minutes be between 200-400 ml volume	II-1 VII-5
		2. An overoxidized or underfed sludge will sink like a rock during the first 5 minutes and 60 minutes will be between	

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		50 and 150 ml volume. 3. An underoxidized or overfed sludge will settle at a very slow, almost constant rate for the entire 60 minutes and end up at a volume of 400 ml or more.	
	2. Calculate settled sludge concentration for each 5 minute interval	1. Obtain result of mixed liquor centrifuge test-call this "aeration tank concentration" 2. Use formula: settled sludge concentration equals $\frac{1000 \times \text{aeration tank concentration}}{\text{settled sludge volume at each 5 minute interval}}$ 3. Plot: settled sludge concentration versus sludge settling time 4. Overoxidized sludge will have a settled sludge concentration of 20 or greater. Underoxidized will be 10 or less and normal will be between 10 and 20. 5. The ideal is a sludge that creates a settled sludge concentration plot that is nearly a straight line and terminates at 15.	II-2 II-3
	3. Calculate the ratio of the settled sludge concentration to the return sludge concentration	1. The return sludge concentration is that determined by the centrifuge test 2. The calculation is: $\frac{\text{Settled Sludge Concentration at Any Time from 30-60 Minutes}}{\text{Return Sludge Concentration}}$ 3. This should be between 1.0 and 2.0	II-4

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
5. Application of Results to Process	1. Adjust return sludge pumping rate	1. To maintain the sludge concentration ratio between 1.0 and 2.0 2. As a general rule to reduce the ratio, decrease the return rate, to increase the ratio, increase the return rate	
	2. Adjust sludge wasting rate	1. Always make changes slowly and allow up to a week's time for the long term effect to show in the mixed liquor concentration and settling characteristics 2. Increased wasting results in a slower settling, less dense floc. Decreased wasting results in a dense floc. 3. Calculation of the cell residence time can be used as a wasting guide Calculation: Cell Residence Time = $\frac{\text{Total Sludge Units in System}}{\text{(Units Wasted/Day + Units in Effluent/Day)}}$ 4. This should be between 5 and 7 days on the average	VII-3
	3. Check sludge detention time in clarifiers	1. Calculate mean sludge concentration = aeration tank concentration + $\frac{\text{Return Sludge Concentration}}{2}$	II-5, VII-3
	4. Calculate the sludge units in the clarifier	1. Clarifier sludge units equals volume of sludge blanket x mean sludge concentration	II-6
	5. Calculate the sludge units being returned	1. Sludge units returned equals return sludge concentration x return flow rate	II-5

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	6. Calculate sludge detention time in the clarifiers	1. Time is $\frac{\text{Clarifier Sludge Units}}{\text{Return Sludge Units/Hour}}$ 2. Should not exceed 1 hour	II-6
	7. Adjust the aeration rate	1. To maintain 1-3 mg/1 D.O. in the aeration tank	
	8. Perform the relative oxygen demand test	1. Use a fresh grab sample of effluent, influent and return activated sludge 2. Use oxygen probe (Preferably with an agitator), standard BOD bottles and a magnetic stirrer. 3. Take flow readings at time of sampling 4. Prepare 2 mixtures for testing. One of return sludge and influent, and one of return sludge and effluent. Mix in same ratio as in plant. If influent flow is 10 MGD and return flow is 4 MGD, mix $\frac{10}{4}$ or 1000 ml influent with 400 ml return sludge. Do the same for the effluent. Use care not to aerate any more than necessary. 5. Set up on magnetic stirrer, insert D.O. probe and record the D.O. changes on each for a 5 minute period, once each minute. 6. Calculate the final dissolved oxygen ratio of $\frac{\text{change in D.O./minute for Return Sludge + Influent}}{\text{Return Sludge + Effluent}}$ = D.O. RATIO	X-2 X-6 X-6 X-6
	9. Interpret relative oxygen demand test	1. An active aerator mixture with a ratio greater than 4.0 usually will indicate a poor settling sludge-not having enough D.O. or enough aeration time, or aerator	

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		solids too low or inadequate return rate.	
		2. A ratio less than 2.0 usually indicates a mixture that is overoxidized where too much air is being applied or aeration tank detention time is too long or the aeration tank solids are in excess of what is needed.	VII-2
		3. The values of 2 and 4 are relative and other values may be found more satisfactory depending on each plant. Somewhere between zero change in D.O. and a very high change in D.O. is the acceptable range of operation. In any case there will be close correlation with the first control method mentioned above.	VII-2
		4. Air supply adequate to maintain satisfactory D.O. is a first consideration. Other conditions such as pH, temperature, mixing, toxicity, loading, aeration tank solids concentration, will be reflected in ΔD.O./minute. The ratio and observed magnitude of response will suggest corrective action needed.	VII-4
		5. An active aerator mixture (high ΔD.O./min.) is unlikely to settle rapidly. No D.O./min. indicates a dead sludge. Somewhere between is the preferred zone of operation. ΔD.O./min. should move upward and downward within this acceptable range according to temperature, feed and stabilization of the feed-sludge mix. Each plant will have an effect upon the acceptable range depending on aerator/clarifier tank ratios, mixing, oxygenation,	VII-5

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		efficiencies, and loading. As relative loading approaches design limits the acceptable control limits tighten. 6. Conventional activated sludge at a MLSS range of 2000 to 3000 mg/l commonly will settle satisfactorily if Δ DO/min. is somewhere between 0.3 and 0.8. A new feed with this RS should increase Δ DO/min. from 2 to 5 times. 7. A small increase in Δ DO/min. upon feeding suggests a dilute feed, a stable feed, unfavorable conditions, a low load ratio, or an unacceptable feed. 8. A large increase in Δ DO/min. upon feeding suggests that air must be increased, if possible, load distribution among multiple tanks needs correction, aeration tank solids should be increased, or the load needs to be spread along the tank (step fed or contact stabilized). If these corrections are not feasible, add coagulants to knock the solids down during the overload or activated carbon to assist adsorption. 9. A decrease in Δ DO/min. upon adding new feed indicates a toxic feed or unfavorable conditions. Hold all the sludge you can in the aerator, step or contact feed, if possible, spread the load to minimize toxic concentrations at any one point. Add coagulants or activated carbon powder to assist treatment and to permit sludge recovery.	

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		10. In event that the unfed sludge Δ DO/min. starts upward approaching the usual levels for fed sludge, increase aeration tank solids and oxidative pressures, use contact or step mode of operating. This is approaching a bulking condition which will show as a high sludge blanket if not corrected. Use coagulants to concentrate the sludge and reduce the fraction of process sludge in the clarifier. Be sure that pH (in the aerator) does not get out of range during coagulant addition. Coagulant aids may be beneficial.	III-2
		11. Observe visual, blanket depths, settling curves, DOs, turbidities and conventional tests for guidance in controls for Δ DO/min. The oxygen use rate tests will indicate problems before clarification upsets. They provide time to make corrections to avoid upsets. The peak load rate of the day is the critical one. If Δ DO/min. indicates that this can be handled the rest is easier. Excessive shocks are clearly indicated and you have numbers which can be interpreted.	
	10. Adjust blower output	1. From results of D.O. test	

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D. ABNORMAL OPERATION			
1. Bulking Sludge	1. Observe settleometer tests	1. Note slowly settling sludge with extremely clear supernatant and lack of straggler floc. Sludge light brown to gray in color	VIII-1
		2. Plot settling and SSC curves	II-3
	2. Observe clarifier	1. Sludge blanket >1/2 of tank volume or sludge going over the weirs	VI-10
	3. Observe aeration tank	1. Note: may possibly have white foam over much of tank surface	
	4. Note oxygen demand ratio	1. May be 2 or less	
	5. Correct sludge condition for long term operation	1. Increase aeration rate as per oxygen demand test	VII-4
		2. Aerator D.O. between 1 and 3 mg/l	
		3. Adjust return rate to increase the sludge concentration ratio. This adjustment will be made by deciding what return sludge concentration is desired and the settled sludge concentration at time t.	VII-4
		4. Adjust wasting - reduce the wasting rate to decrease the settling rate of the sludge in the system.	
		5. Run settleometer and centrifuge test and perform calculations at least once per 4 hours until condition is corrected.	VII-4

STANDARD OPERATING JOB PROCEDURES

SOJP NO 5 Prepared by George Mason Date 11-26-72

PROCESS Activated Sludge-Aeration & Sedimentation Approved by _____

OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
2. Excessive Solids Carry-over	1. Observe clarifier	1. Excessive solids in supernatant carrying over to effluent 2. Note the blanket rising 3. Blanket <1/4 of tank volume	VIII-2 VII-5, VI-11
	2. Observe settleometer test	1. Sludge settles very rapidly, leaving solids behind in supernate	
	3. Calculate and plot settled sludge concentration curve and sludge concentration ratio	1. End point of curve is greater than 20 and sludge concentration curve is approaching or greater than 2.0	II-1
	4. Run oxygen demand test and calculate influent-effluent ratio	1. Ratio is greater than 4.0	X-6
	5. Make process adjustments for long term results	1. Decrease aeration rate as per oxygen demand test 2. 1-3 mg/l of D.O. in aerator at least 3. Adjust return rate to decrease the sludge concentration ratio. This adjustment is made based on the desired return sludge concentration as obtained from the settled sludge concentration test at time t. 4. Adjust wasting rate. Increased wasting to decrease the settling rate of the sludge in the system. 5. Run settleometer and centrifuge tests at least once each 4 hours until the condition is corrected.	VII-2

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STANDARD OPERATING JOB PROCEDURES

SOJP NO 5 Prepared by George Mason Date 11-26-72

PROCESS Activated Sludge-Aeration & Sedimentation Approved by _____

OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
CAUTION: Some operations may seem to be the reverse of what should be done. Usually the process will appear to deteriorate at first but patience must be practiced and a week or more may pass before positive results begin to show. In correcting both the above abnormalities, use caution, not to over-correct. Sample and analyze as much as necessary to avoid over-correction. Don't confuse effects with process dynamics. Sedimentation rates, foam, color, odor, rising solids, effluent quality, etc. are effects of sludge, load and conditions. All are interrelated with sludge activities that may be assessed in terms of process DO and DO changes. If the DO dynamics are adjusted in line with plant, load and conditions, upgraded performance follows.			
3. Excessive White Foam	1. Observe aeration tanks	1. Foam, light, white, covers most of surface	VI-4
	2. Make process adjustments	1. Increase sludge concentration ratio toward 1.5 and the settled sludge concentration to 15	VI-4
4. Excessive Brown Foam	1. Observe aeration tanks	1. Heavy, thick brown foam covers surface of tank	VI-4
	2. Make process adjustments	1. Use process control tests to reduce the sludge concentration ratio to 1.0 and the settled sludge concentration plot to end at 15	
5. Excessive Ash or Floating Materials on Clarifier	1. Observe clarifier surface	1. Light, whitish material all over surface	VI-11
	2. Make process adjustments	1. Same as 4.2.1 above	

STANDARD OPERATING JOB PROCEDURES

SOJP NO 5 Prepared by George Mason Date 11-26-72

PROCESS Activated Sludge-Aeration & Sedimentation Approved by _____

OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
E. SHUTDOWN OF ONE CLARIFIER			
1. Process Control	1. Increase solids density to maximum	1. To provide proper settling with less surface area 2. Sludge concentration ratio to about 2.0 3. Increase aeration rate 4. Increase aeration detention time 5. Increase aeration tank concentration by decreasing wasting	
2. Valving for One Clarifier Shut Down	1. Close clarifier inlet valve 3 or 4	1. To stop influent to clarifier	
	2. Open valve 23	1. To allow mixed liquor to flow to remaining clarifier	
	3. Pump sludge from shut-down clarifier to aerator	1. Until fairly clear water runs in return stream	
	4. Shut down return pumps	1. From clarifier going out of service	
	5. Close valves 5 and 6	1. To stop return pumping	
	6. Shut down sludge collector	1. In tank going out of service	
	7. Lock out and tag sweep drive power	1. To prevent accidental starts	XII-2
	8. Lock out and tag return pump power	1. To prevent accidental starts	XII-2

STANDARD OPERATING JOB PROCEDURES

SOJP NO 5 Prepared by George Mason Date 11-26-72

PROCESS Activated Sludge-Aeration & Sedimentation Approved by _____

OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	9. Drain clarifier or pump out	1. To plant sewer	
	10. Clean tank	1. Remove all solids 2. Prevent odor	

TRAINING GUIDE

SECTION	TOPIC
I	Operating Theory
II	Educational Concepts - Mathematics
III	Educational Concepts - Science
IV	Educational Concepts - Communications
V	Process Equipment
VI	Process Flow - Characterization
VII	Process Control
VIII	Abnormal Operations - Trouble Shooting
IX	Maintenance Practices
X	Laboratory Practices
XI	Instrumentation - Automation
XII	Safety Practices
XIII	Records Reports

OPERATING THEORY

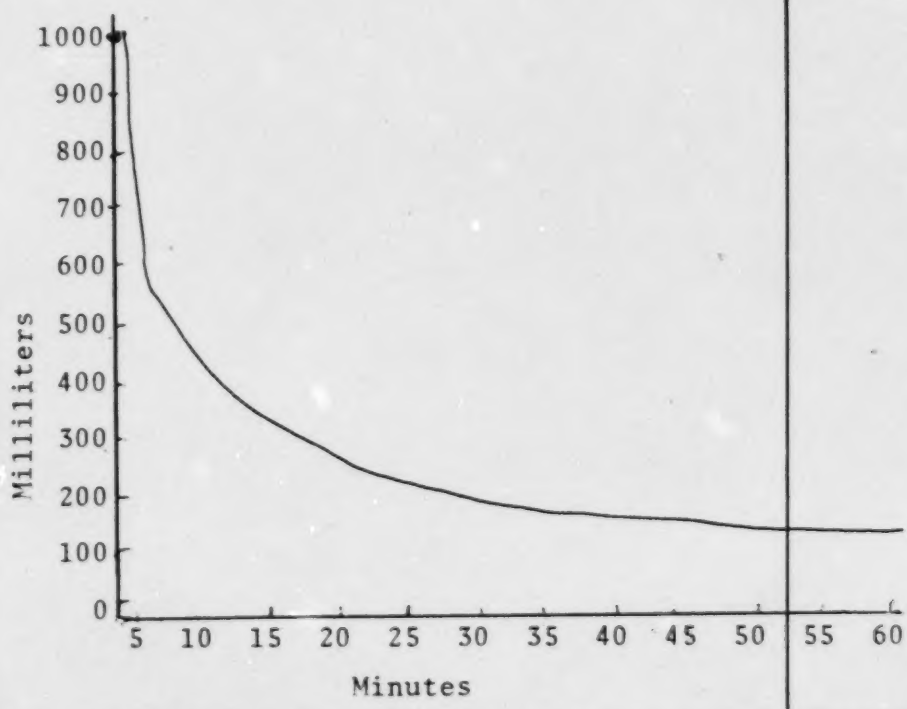
TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
I-1 [B]	The operation of activated sludge hinges on the success of uptake of the impurities in the waste stream and the separation of the activated sludge solids from the water by gravity settling. This requires adequate oxygen for the bacteria in the sludge to utilize the food in the waste stream, adequate mixing to bring the bacteria into contact with the food, enough bacteria to utilize the food nearly completely and adequate time for the bacteria to use the food. Also the settling basin must provide sufficient storage space for sludge in the bottom of the tank to collect so that it can be returned to the aeration tank for more feeding and mixing. These are the requirements and all control methods and schemes that are successful are based on these principles.	Biology for Sanitary Engineers (Sawyer) WPCF-MOP# New York State Manual Washington State Manual Sacramento State Correspondence Course

EDUCATIONAL CONCEPTS -- MATHEMATICS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
II-1 [C-I.3.1.5] [C-I.4.1.1] [D.2.3.1]	How to make a graph of volume of sludge versus time (1) Mark a horizontal line in even intervals, each representing 5 minutes up to 60 (2) Mark a vertical line in even intervals each representing 50 ml. (3) Place a dot at each point observed, at the intersection of the appropriate volume and time until the 60 minute period is up	

Example:

Time	Volume
0 min.	1000 ml
5 "	580 "
10 "	430 "
15 "	310 "
20 "	270 "
30 "	200 "
40 "	180 "
50 "	150 "
60 "	140 "

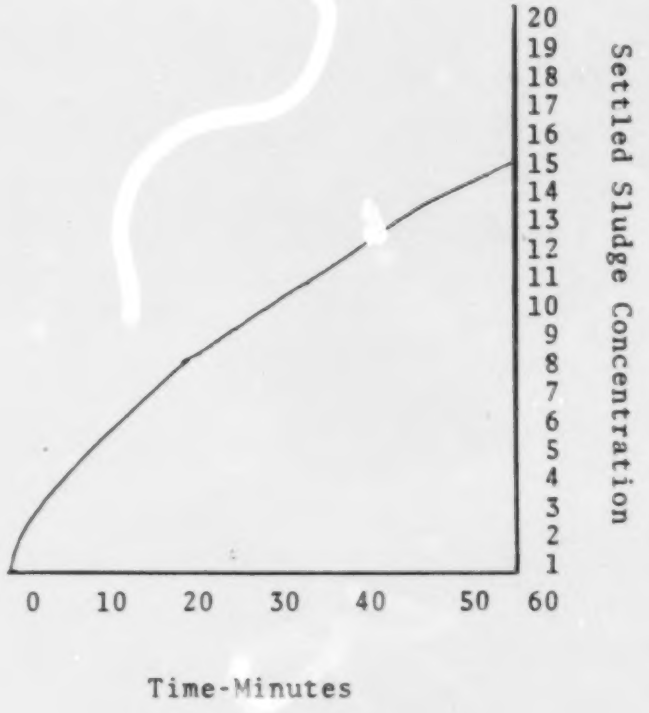


EDUCATIONAL CONCEPTS -- MATHEMATICS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
II-2 [C-I.4.2.1]	Calculate the settled sludge concentration. FORMULA: Settled Sludge Conc. = $\frac{1000 \times \text{Aeration Tank Conc.}}{\text{Settled Sludge Volume at Recorded Intervals}}$ EXAMPLE: Aeration Tank Concentration = 2.1% Settled Sludge Volume 5 min. = 580 $\frac{1000 \times 2.1}{580} = 3.6$ 10 min. = 430 $\frac{1000 \times 2.1}{430} = 4.9$ 15 min. - 310 $\frac{1000 \times 2.1}{310} = 6.8$ 20 min. = 270 $\frac{1000 \times 2.1}{270} = 7.7$ 30 min. = 200 $\frac{1000 \times 2.1}{200} = 10.5$ 40 min. = 180 $\frac{1000 \times 2.1}{180} = 11.4$ 50 min. = 150 $\frac{1000 \times 2.1}{150} = 14$ 60 min. = 140 $\frac{1000 \times 2.1}{140} = 15$	

EDUCATIONAL CONCEPTS -- MATHEMATICS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
II-3 [C-I.4.2.3] [D.1.1.2]	Plot of settled sludge concentration using the figures from the foregoing example	



EDUCATIONAL CONCEPTS -- MATHEMATICS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
II-4 [C-I.4.3.2]	Calculate ratio of the settled sludge concentration to the return sludge concentration. EXAMPLE: Settled Sludge Concentration at 50 minutes equals 14 Return sludge concentration equals 14 Concentration Ratio = $\frac{14}{14}$ = 1.0	
II-5 [C-I.5.3.1] [C-I.5.5.1]	Calculation of mean sludge concentration Aeration tank concentration = 1.4 Return sludge concentration = 14 Mean sludge concentration = $\frac{1.4 + 14}{2}$ = 7.7	
II-6 [C-I.5.4.1] [C-I.5.6.1]	Clarifier Sludge Units = Volume of Sludge Blanket x Mean Sludge Concentration Volume of Sludge Blanket (1) Circular Tank 3.14 x (radius x radius) x depth of blanket x 7.5 (2) Rectangular Tank Length x Width x Depth of Blanket x 7.5 EXAMPLE: Circular clarifier - 100 ft. in diameter Blanket Depth - 3 feet 3.4 x (50x50) x 3x7.5 = .176625 MG 0.176 x 7.7 = 1.36 Clarifier Sludge Units	

EDUCATIONAL CONCEPTS -- MATHEMATICS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
	Preparing a mixture in proportion to the plant flows: If flow is 10 MGD and return sludge flow is 4 MGD, then mixtures will be made in a ratio of 10 to 4. That is 10 gallons of influent and 4 gallons of return sludge or 10 liters of influent and 4 liters of return sludge. Ratio of changes of D.O. per minute Example: MIXTURE OF INFLUENT AND RETURN SLUDGE D.O. at start = 8 mg/l D.O. one minute later = 4 mg/l Δ D.O. = 8 - 7.2 = 0.8 MIXTURE OF EFFLUENT AND RETURN SLUDGE D.O. at start = 8 mg/l D.O. one minute later = 7 mg/l Δ D.O./min. = 8 - 7.8 = 0.2 D.O. RATIO = $\frac{0.8}{0.2} = 4$	SLIDE-TAPE SERIES. FERD LUDZAK EPA-W.Q.O. CINCINNATI, OHIO LABORATORIES

EDUCATIONAL CONCEPTS -- SCIENCE

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
III-1 [C-I.2.1.4] [C.1.5.3] [C-I.2.6.1]	Examination of the aeration tank solids and the return sludge solids can be very revealing of the state of oxidation of the organisms. Examination requires only a simple microscope with reasonable resolution at 100 power. A slide should be prepared using a drop of well mixed sample with a coverslip placed over it. The floc should have crisp clean edges and a large variety of protozoa should be present. The presence of many small flagellates and strings extending out of and mixed in the floc indicates an underoxidized, young floc. If the floc is small with crisp edges and many large rotifers are present, the floc is overoxidized. The presence of a variety of types and many protozoa indicates a balanced process. In many cases, the organism balance in the process will indicate problems in the process long before they actually occur.	
III-2 [C-I. 5.9.10]	pH Control. In adding coagulant aids always monitor the aeration tank pH using a pH meter. Many coagulants are acidic or basic and any pH range outside of 6.0-8.0 will affect the microorganisms adversely and halt biological action.	

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
IV-1 [A.1.1.1] [A.1.2.1]	Tagging of valves and power sources. A tag placed on any value or power source should have the following information on it: (1) Date (2) Time (3) Name of individual tagging (4) Any other pertinent information (5) Use Dept. of Labor & Industries standard electrical tags for lockout (6) Be sure tag is attached securely and in place where it can't be missed.	DEPT. OF LABOR OSHA STD. LOCKOUT PROCEDURES. PLANT SAFETY MANUAL

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
V-1 [A.1.1.1]	Observe indicators on valve to ascertain valve position. If not marked, mark the fully open and fully closed positions with a permanent marker.	
V-2 [A.1.2.1]	Lock with bar provided on power switchgear circuit breaker.	
V-3 [A.2.1.1]	Water stops are provided to keep water from leaking in or out of the tank at the joints. If water is leaking in, repairs should be made before putting the tank in service, as leaks going out could contaminate the surrounding ground water.	
V-4 [A.2.2.1]	An open drain could make the process inoperable since this is an uncontrolled wasting of sludge. Make sure drain operators are lubricated and operate freely since they will be needed next time you need to drain the tank and the mechanism may be inaccessible with the tank full.	
V-5 [A.2.3.1]	These valves are to keep the tank from floating when empty and their free operation is absolutely necessary. They may have to be pushed down before putting the tank into service, particularily if it has been out for a long period of time.	
V-6 [A.2.5.1]	Antifoam sprays should be operable and unplugged. They will probably be needed during start up of the process, as foam is common during the first weeks of operation.	
V-7 [A.2.6.1]	Absolutely clean sparger ports are necessary to insure adequate agitation and air supply.	
V-8 [A.2.7.1]	Mis-seated O-rings lead to air leakage and inefficiency, and lubrication is necessary to prevent O-ring cracking and to insure easy operation of the swing arms.	

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
V-9 [A.3.1.1]	Any debris in the clarifier will lead to shear pin breakage and complete process shutdown.	
V-10 [A.3.1.2]	Baffles are subject to hydraulic forces that could break them loose and cause process shutdown unless they are secured tightly.	
V-11 [A.3.1.3]	Weirs must be level to eliminate short-circuiting possibilities and process hydraulic upset.	
V-12 [A.3.1.5]	Gratings should be securely bolted even if occasional removal is necessary. This will keep them out of the tank.	
V-13 [A.3.3.1]	Same as A.2.2.1 and A.2.3.1.	
V.14 [A.3.4.1]	Make sure there are adequate threads through the tie rods to support the arms.	
V-15 [A.3.4.2] [A.3.4.3]	The arms must be absolutely level and have the proper clearance from the tank floor to prevent septic sludge problems or pin shearing problems from arm hang-up on the floor. Clearance should be from 3/4" to 1" all the way around.	
V-16 [A.3.5.1] [A.3.5.2]	Blockage of any feed port will cause improper distribution of sludge and promote short-circuiting.	
V-17 [A.3.6.1]	Scum removal valves should operate freely through the whole range to allow for scum removal at any tank level.	
V-18 [A.4.1.1]	Piping should be in good condition in and out.	Maintenance Engineering Handbook - Morrow

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
V-19 [A.4.1.2] [A.4.1.3]	Pitting usually indicates electrolysis and an engineer should be brought in to correct it if it is extensive. Loose joints mean leaks. Valves must work freely or be repaired.	
V-20 [A.4.2.1]	Couplings must be bolted properly and alignment of drive and pump must be within tolerances or rapid failure of the coupling will occur. This failure could cause severe damage to pump and motor bearings.	Morrow Mfg. Specifications
V-21 [A.4.2.2]	Adequate flow of seal water must be present to keep sewage out of the wear surfaces of the rotating pump. Inadequate pressure or volume will result in rapid wear, costly repairs and down time. A drip per second from packing is reasonable rule of thumb.	Morrow
V-22 [A.4.2.3]	Lubrication of electric drives is usually minimal, from 6 months to once/year.	Mfg. Specifications
V-23 [A.4.2.4]	Test by jogging start button. (Centrifugal pumps only). If positive displacement, do not jog unless suction and discharge valves are open. (See Pump & Valve Section).	
V-24 [A.4.3.1]	Check to see all personnel are clear of sweep arm before jogging motor start button.	
V-25 [A.4.3.2]	If motor is not securely mounted and aligned, serious damage will be done to unit.	Mfg. Specifications Morrow
V-26 [A.4.3.3]	Oil in gear reducer should be at operating mark and clean.	Mfg. Specifications
V-27 [A.4.3.4]	Only the shear pin supplied by the manufacturer should be used. If any other device is used, you have no protection.	Mfg. Specifications

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
V-28 [A.4.3.5]	Separate the shear faces and see that they operate freely. Grease with waterproof grease or use a Teflon interface as these commonly rust or freeze together.	
V-29 [A.4.3.6]	Inspect carefully, as long tubes to carry grease commonly break and grease may not get to the gears. Use manufacturer's specified grease only.	Mfg. Specifications
V-30 [A.4.4.1]	To prevent damage to Mag flow meters, it is good practice to have the power off whenever they are not full of liquid.	Mfg. Inst. (Fisher Porter or Foxboro)
V-31 [A.4.4.2]	Meter should read "0" with no flow when on.	
V-32 [A.4.5.1]	Blower filters should be absolutely clean on start up to allow full flow of air and eliminate any restrictions.	
V-33 [A.4.5.2]	Most blowers will not start unless all alarms indicating malfunctions are cleared.	Mfg. Specifications
V-34 [A.4.5.3]	Many blowers are designed to have an oil temperature of at least 70°F before start up to prevent any damage to oil bathed bearings and gears.	Mfg. Specifications
V-35 [A.4.5.4]	Cooling water flow is absolutely necessary to carry heat away from the bearings in these high speed blowers.	Mfg. Specifications Plant Manual
V-36 [A.4.5.5]	Inlet and discharge valves of the blowers are usually set up with stops to allow some flow of air on start up and prevent over-pressuring or surge conditions which can lead to blower damage.	
V-37 [B.1.2.1]	Always fill tanks slowly to prevent hydraulic damage to structures and equipment. Usually valve 1/8 to 1/4 open is adequate.	

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
V-38 [B.1.3.1]	Examine all potential drainage places from aeration tanks, clarifiers, and return lines. Any unplanned losses could upset the process or prevent establishment of a culture.	
V-39 [B.1.4.1]	Start blowers as soon as spargers are covered to prevent plugging.	
V-40 [B.1.4.2]	Remove locks and close circuit breaker. Push start button.	
V-41 [B.1.4.4]	Fifty percent of rated output will bring blower output up above surge point and supply all air necessary for start-up.	Mfg. Specifications
V-42 [B.1.5.1]	Water just covering suction arms will reduce apparent weight of arms and make start easier. Observe arm rotation for smooth, even operation. Any roughness or stops call for immediate stopping and draining of all equipment and corrective maintenance.	Mfg. Specifications Plant Manual
V-43 [B.1.7.1] [B.1.8.1] [B.1.8.2] [B.1.8.3]	Push start button and set initially to 50% of plant flow. Make adjustments later by process demand. (See Process Control Section).	
V-44 [C.2.1.1]	Any steady deviation on the negative side of 0 for the blower intake indicates plugging filters. These should be cleaned.	
V-45 [C.2.1.2] [C.2.1.3] [C.2.1.4]	Generally in the 90-150°F range oil temperature oil pressure generally 20-30 psi on blower. Cooling water adequate to keep oil temperature within specifications.	Mfg. Specifications Plant Manual
V-46 [C.2.1.5]	Ammeters must be in normal range. If otherwise serious problems are occurring and immediate shutdown is advisable.	Mfg. Specifications

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
V-47 [C.2.1.6]	A power factor greater than 0.85 is required through most of the nation. Penalties are usually attached to P.F. loadings less than this on either the lead or log side. A rheostat is usually supplied for correction.	Mfg. Specifications Plant Manual
V-48 [C.2.3.1] [C.2.1.7] [C.2.2.1]	High bearing temperatures will usually coincide with high oil temperatures which generally means a shutdown and repair are called for.	Mfg. Specifications Morrow
V-49 [C.2.1.8]	Vibration monitoring is unusual in smaller installations but can give immediate or trend information on equipment failure or problems	Morrow
V-50 [C.2.2.2] [C.2.3.1]	A 40°C rise motor will feel very hot to the touch and caution should be used not to burn your hands. Experience will tell you when the motor is too hot.	
V-51 [C.2.3.1] [C.2.2.3]	A noisy coupling indicates overload or mechanical damage due to misalignment. Call maintenance.	
V-52 [C.2.2.4] [C.2.2.6] [C.2.3.1]	Pump output (flow) and pump discharge pressure are keys to the condition of the pump and piping. Learn the normal values. Drastic, uncalled for changes can lead to early discovery of malfunction.	
V-53 [C.4.1.2] [C.4.2.2] [C.4.3.1] [C.4.4.1] [C.4.5.1]	Cleaning of all structures at the water level is an absolute requirement on a routine basis. Failure to do so will create an unhealthy, nauseous, stinking mess, due to slime, grease and algal accumulations. Use a high pressure sprayer or high pressure hose.	
V-54 [C.4.6.1]	Clean equipment is easier to maintain, makes malfunctions show more readily (e.g. oil leaks) and prevents equipment damage from mechanical junk getting into working parts.	
V-55 [C.4.7.2]	A control panel with extra materials on it can make operation confusing and unsafe.	

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
V-56 [C.4.9.1]	All valves should be lubricated and turned on a routine basis. Use recommended lubricants. This makes the valve a valuable tool, particularly when you really need it.	Mfg. Specifications Plant Manual

PROCESS FLOW--CHARACTERIZATION

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VI-1 [C.1.1.1]	The surface of the aeration tank should have an even roll with no dead spots. Particularly watch for plugged sprayers. A dye test may be required at first to determine whether or not a dead core may exist in a spiral flow aeration tank. If this is so, major modifications of air supply may be necessary.	Activated Sludge Process Operational Control A. West P.E. EPA Cincinnati, Ohio
VI-2 [C.1.1.2] [C.1.5.1]	The color of the sludge should be a reddish brown. Any other variations may be caused by dyes or colored compounds in the influent, underoxidation causing the sludge to get very dark or to tend toward gray.	
VI-3 [C.1.1.3] [C.1.5.2]	Pick up a handful of loamy earth and compare the odors. Any other odor means trouble, usually overloading and underoxidation.	
VI-4 [C.1.1.4] [D.3.1.1] [D.4.1.1] [D.3.2.1]	There will usually be some small amount of light brown foam. If the foam is white and abundant, the aeration solids concentration is too low. If it is heavy and dark the aeration tank solids are too heavy. These are only guidelines and adequate testing must be done before corrections are made.	
VI-5 [C.1.2.1]	Even ideal control will leave some scum on the clarifiers. The amount will be small and the skimming devices should clean it all on each pass.	
VI-6 [C.1.2.2]	There will always be some small amount of floc varying from very fine to 1 mm in diameter rising in the clarifiers, even under good control. The amount should be very small and not sufficient to interfere with turbidity measurements.	
VI-7 [C.1.2.3]	Some suspended materials (5 mg/l or so) will be present. This should not interfere with the turbidity readings.	

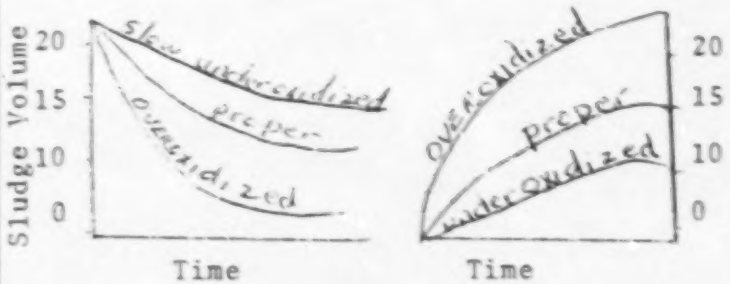
PROCESS FLOW--CHARACTERIZATION

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VI-8 [C.1.3.1] [C.2.4.1]	Using an air lift or light device, determine the sludge blanket depth. Anything less than 1/2 the tank depth indicates process trouble.	
VI-9 [C.1.4.1] [C.1.4.2]	An even flow over the weirs prevents short circuiting and consequent hydraulic upsets leading to excess solids in the effluent.	
VI-10 [D.1.2.1]	Bulking sludge. The solids concentration in the clarifier will be almost the same from top to bottom. There will be no area of clear supernate on the clarifiers or if there is it will be minimum and the blanket will be visible just below the surface. The effluent solids will be almost equal to the aeration tank solids. This will occur even below design flows.	
VI-11 [D.2.1.1] [D.5.1.1]	Excessive solids carry-over can be of several forms. Very small pinhead floc going over the weirs indicates over-oxidized sludge. Large chunks of light brown materials indicate nitrification and denitrification or too much air and aeration tank solids too heavy. Dark brown to black chunks indicate septicity.	

PROCESS CONTROL

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VII-1 [C.1.2]	Sludge detention time in the clarifier should not exceed 1 hour per cycle and not more than 15% of the day. Overlong clarifier detention times lead to reduced aeration times and consequently under-oxidized sludge. This can be used to make the sludge more or less dense.	
VII-2 [B.1.8.3] [D.2.5.1] [C-I.5.9.2] [C-I.5.9.3]	The oxidation index gives the ratio of the influent oxygen demand to the effluent oxygen demand. This is a simple test and should work in all facilities. If the ratio is greater than 4, the aeration rate or aeration time should be increased. Clarifier detention time should be reduced. This indicates an overoxidized sludge and the results of the settleometer tests, sludge concentration ratios, and settled sludge concentration should verify this. The opposite is true if the index is less than 2.	
VII-3 C-I.5.2.3] C-I.5.3.1]	Cell residence time or the average time that a particle remains in the system can also be used as a wasting guide. Cell residence times less than 5 days lead to underoxidized, bulking sludge and residence times over 7 days lead to overoxidized dense sludge with a poor supernate.	
VII-4 [C.3.1.1] C-I.5.9.4] [D.1.5.1] [D.1.5.2] [D.1.5.5]	The concentration of dissolved oxygen must always be adequate to supply the organisms and support their metabolism. One technique is to base your aeration supply on the measurement of the dissolved oxygen in the tank. The dissolved oxygen measured is that present above the demand of the organisms and is necessary to provide the driving force to get oxygen to the organisms. An excess of 1.0-3.0 ppm will usually be satisfactory and the highest concentration will usually be at the tank exit. The lowest concentration at the inlet.	West

PROCESS CONTROL

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VII-5 [C-I.4.1.1] [C-I.5.9.5] [D.2.1.1]	Close observation of the settleometer test is absolutely necessary to process control. Separation of solids from the liquid should be fairly rapid at first and a clean supernate should be left behind. A supernate may be exceptionally clear, but with a slow initial separation indicating an underoxidized, bulking condition, and unless clarifiers are oversized, the process is in imminent danger. As a rule of thumb, increase the return sludge rate and decrease wasting for a long term correction. A supernate that is dirty with many small discrete particles in it and extremely rapid separation indicates an overoxidized, dense sludge that will not produce a good effluent. This is the so-called "safe" sludge but the effluent will never be what it could be. In general, reduce the return rate and increase wasting. If a murky supernate without a quantity of suspended solids occurs, the correction will most likely be made by increasing the aeration rate. The surface of the clarifiers will also look like primary effluent. Properly oxidized sludge settles at a rate that gives a clear supernate an almost straight line settled sludge concentration curve and a sludge concentration ratio of about 1.0.  	

PROCESS CONTROL

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VII-6 [A.2.5.1]	Distribution of sprayers is critical to assure an adequate supply of oxygen to the process. Usual practice is to supply about 25% more sprayers to the end of the tank where the flow enters the tank. This is called Tapered Aeration. The sprayers must be clean to assure adequate flow.	
VII-7 [B.1.1.1] [B.1.8.3]	Determination of Number of Tanks Required When starting the facility, it will be necessary to compute the detention time in order to decide on the number of tanks to be placed in service. As the flow increases, it would be wise to recompute this from time to time to assure proper operating parameters as well as predicting when an additional tank should be placed in service. The retention time should not exceed 900 minutes not go below 400 minutes on an average daily basis.	
VII-8 [B.1.8.3]	The idea, when starting an activated sludge culture is to recover all settleable floc, therefore a higher than normal return rate is necessary.	

ABNORMAL OPERATION: TROUBLE SHOOTING

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VIII-1 [D.1.1.1]	Bulking Sludge is an activated sludge that will not settle in the clarifier because of the sludge characteristics, not because of hydraulic influences. It is a slowly settling sludge in the settleometer and it will not compact. Care must be taken not to confuse this with a nitrified or overoxidized sludge that settles rapidly but rises as a unit very soon after settling. In some cases, in less than the time required for the settleometer test. The basic cause of bulking is overloading or underoxidation of the sludge. All factors must be carefully analyzed. The general solutions are: (1) Increase the aeration tank solids concentration, (2) Increase the length of time of aeration, (3) Increase the aeration rate, (4) Decrease the clarifier solids detention time. This can all be accomplished using the techniques presented in the process control section. If the plant is hydraulically underloaded, it may be desirable to operate more toward a bulking sludge since in general the supernate produced is very clear. CAUTION! This is very touchy and very close control is necessary.	Al West
VIII-2 [D.2.1.1] [E.1.1.1]	Excessive Solids Carry-over refers to solids going to the effluent and is differentiated from bulking sludge by a sludge blanket that occupies less than 1/4 of the clarifier depth and the solids carried over are very fine and dispersed. This is generally due to an overoxidized sludge and can be corrected by reducing the aeration tank solids concentration or reducing the aeration detention time. In some cases where hydraulic, not organic, overload is expected, it may be desirable to control the process so that complete hydraulic washout does not occur. The correction to this problem can be found in the Process Control Section. CAUTION! Use extreme care if attempting to control in this mode since solids losses can be expected to be high.	Al West

MAINTENANCE PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
	SEE SECTION V	

LABORATORY PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
X-1 [C-I.1.1.1] [C-I.1.2.1] [C-I.1.3.1] [C-I.1.4.1] [C-I.2.5.1]	Collect a flow paced composite sample consisting of at least 4 samples each 8 hours. Using a clean sampling cup, dip the sample from the stream in a well mixed area. Always sample from the same place and use care that large chunks are omitted and that the walls are not scraped. Pour the appropriate amount of sample into the sample container, cap and put into refrigerator at 4°C immediately. The quantity of sample to take per sampling time is determined by how much sample is required per day and the plant flow. If the average plant flow is 10 MGD and the total quantity requirement is 4 liters, and 12 samples per day are to be taken, the quantity per MGD would be: $\frac{4 \text{ liters}}{12 \text{ samples}} = 0.33 \text{ liters/sample}$ $\frac{0.3 \text{ liters}}{10 \text{ MGD}} = 0.01 \text{ l/MGD or } 30 \text{ ml/MGD}$ EXAMPLE: Time Flow Quantity of Sample 0800 5 MGD 5x30 or 150 ml of sample 1000 8 MGD 8x30 or 240 ml of sample 1200 12 MGD 12x30 or 360 ml of sample Use care that the proper flows are used for each sampling, i.e., use influent flow for influent sample and return flow for return sludge sample.	CLEMSON UNIVERSITY CEWT. BEHAVIORAL OBJECTIVES FOR SCREENING AND GRINDING
X-2 [C-I.1.5.1] [C-I.1.6.1] [C-I.3.3.1] [C-I.5.8.1]	Grab Sample using a clean container and sampling from a well mixed area of the stream. Avoid large chunks and scraping of the walls. Process grab samples immediately.	

LABORATORY PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
X-3 [C-I.2.1.1] [C-I.2.2.1] [C-I.2.3.1]	Take sample at same place every time. Avoid agitation caused by transportation and process immediately.	Al West
X-4 [C-I.2.1.2] [C-I.3.1.2] [C-I.3.1.3] [C-I.3.1.4] [C-I.3.1.1]	Stir sample very gently and pour carefully into the settleometer. Avoid any needless agitation. Pour to the 2 liter mark. Observe very carefully the first 30 minutes for rapidity of separation and completeness of separation record readings every 5 minutes and write observations about separation and supernate appearance on standard form. Record settling every 10 minutes for last 30 minutes. Allow to stand at least one hour after the test. Solids should begin to rise about then if you are controlling properly.	
X-5 [C-I.2.1.3] [C-I.2.2.2] [C-I.3.2.1] [C-I.3.2.2] [C-I.3.2.3] [C-I.3.2.4]	Fill centrifuge tube to mark with well mixed sample and centrifuge at 2000 rpm for 15 minutes. Record solids level as percentage of volume occupied. Standard API tubes are calibrated in percent.	
X-6 [C-I.2.1.5] [C-I.3.4.1] [C-I.3.4.2] [C-I.5.8.4] [C-I.5.8.5] [C-I.5.8.6] [D.2.4.1]	Determine D.O. of sample as soon as it is taken. Use a D.O. probe to accomplish this. It should be 103 mg/l.	

INSTRUMENTATION--AUTOMATION

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
XI-1 [C.2.4.1] [C.2.4.2] [B.1.4.3] [B.1.7.2]	In order to obtain accurate flow measurements, the Parshall flume must be clear of all obstacles. Any obstacle will cause a backup of water and change the water level of the flow chamber. The flow is measured by the level of water in the chamber. The bubble tube is submerged a measured distance in the flow chamber. A constant flow of air is put through the tube. If the level of the water increases or decreases, the back pressure on the air leaving the tube changes. It is this pressure that is measured and converted to the flow rate of the sewage. Purging allows a high pressure stream of air to clear the tube and prevent false readings. This must be done regularly.	

SAFETY PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
XII-1 [A.1.1.1]	Whenever entering any tank into which water or sludge can be discharged, make sure each valve that could permit any flow into the tanks is completely closed and a tag is on it that gives the reason for its being closed. If possible the valve should be padlocked in the closed position.	WPCF SAFETY IN WASTE-WATER WORKS MOP#
XII-2 [A.1.2.1] [E.2.7.1] [E.2.8.1]	If there is any equipment that could be turned on and begin to move and cause the equipment to move, it must be locked out at the switchgear and a tag placed on it saying that the switch must not be closed. The key to the padlock should be in the pocket of the man who is doing the work. If two people are working on the equipment, each man must have his own padlock and key. In this manner, no piece of equipment will be started accidentally and no one will be hurt.	
XII-3 [A.3.1.5]	Gratings on all walkways should be bolted down to prevent tripping and potential falls.	
XII-4 [B.1.1.1]	Make sure all personnel are clear before allowing flow into any tankage. This will prevent drowning.	
XII-5 [C.4.1.2] [C.4.2.2] [C.4.3.1] [C.4.4.1] [C.4.5.1]	Use approved life jackets and safety ropes or harnesses whenever work has to be done over any full tanks that are not protected by rails.	
XII-6 [C.4.6.2]	Do not attempt to wipe down rotating equipment since it is very easy to catch a rag in the rotating shafts and have your hand pulled in behind it. Do not wear loose or floppy clothes around rotating equipment for the same reason.	

SAFETY PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
XII-7 [C.4.7.3] [B.1.1.1]	Loose materials on a control panel could fall or tip onto a start or stop button or cause confusion and false operations. Personnel could be injured by unexpected starts.	
XII-8 [C.4.8.1]	All walkways must be clear of debris to prevent falls.	

RECORDS -- REPORTS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
XIII-1 [A.4.1.1] [C.2.2.4] [C.2.4.3] [C.3.3.1] [C-I.2.6.1]	A complete check list of equipment items should be used each time a routine or special inspection is made. See attached sample. NOTE: ALL REQUIRED WORK AND RECORD SHEETS ARE ATTACHED. (Samples only- adjustments will have to be made.)	

SAMPLE

PROCESS WORK SHEET

DATE_____

OPERATOR_____

TIME_____

SETTLING

TIME	ML.	REMARKS
5		
10		
15		
20		
25		
30		
40		
50		
60		

DISSOLVED OXYGEN_____mg/l

RETURN SLUDGE CONC._____%

AERATION TANK CONC._____%

TURBIDITY ONE _____JTU

TURBIDITY TWO _____JTU

INFLUENT FLOW _____MGD

RETURN FLOW _____MGD

SLUDGE BLANKET_____FT.

WASTE FLOW _____MGD

AERATION RATE _____CFM

INFLUENT + RETURN ΔD.O. _____

EFFLUENT + RETURN ΔD.O. _____

D.O. RATIO _____

CALCULATED VALUES

SETTLED SLUDGE CONC.		RATIO TO RETURN	
TIME	CONC		
5			
10			
15			
20			
25			
30			
40			
50			
60			

CELL RESIDENCE TIME_____

MEAN SLUDGE CONC_____

RETURN SLUDGE UNITS_____

SLUDGE CLARIFIER TIME___

METRO
RENTON SEWAGE TREATMENT PLANT
DAILY LOG SHEET

TIME Date Personnel
Day
Area
Shift
Work Accomplished:

Maintenance:

Operational Problems & Corrections:

Pump Station Alarms & Corrections:

SPECIAL Tests:

COMMENTS:

R-50
2/14/72

SECONDARY AREA CHECK SHEET

DATE _____

EQUIPMENT	2400 to 0730	0730 to 1600	1600 to 2400	REMARKS
1. So. tunnel sump pump #1				
2. So. tunnel sump pump #2				
3. Pri. effluent sampler				
4. Tunnel exhaust fan				
5. Sludge density meter				
6. System 2 CWP				
7. System 2 cond. H_2O pump				
8. Water chiller #1				
9. So. Gallery filter & diff.				
10. So. gallery supply fan				
11. Waste Sludge pump 1S				
12. " " " 2S				
13. " " " 3S				
14. " " " 4S				
5. Aeration blower 3S				
Oil temp. inlet				
Oil temp. outlet				
Oil pressure				
16. RAS 1S pump 1				
17. " 1S " 2				
18. " 2S " 1				
19. " 2S " 2				
20. Aer. gall. sump 1 pump 1				
21. " " " 1 " 2				
22. Aeration blower 1S				
Oil temp inlet				
Oil temp outlet				
Oil pressure				
Brg. temp.				

R-11 Operator _____

(S) Indicates equipment is satisfactory
(Y) Yellow tag indicates equipment requires attention.
( ) Out of service - repairs required.
(T) Trouble corrected during shift.
(G) Maintenance acknowledged Yellow tag.

_____
Chief Operator

EQUIPMENT	2400 to 0730	0730 to 1600	1600 to 2400	REMARKS
47. Turbidity Meter				
Range				
Reading				
48. Treated sewage Cl_2 injector				
49. Cl_2 analyzer controller				
50. Inf. sewer flushing gate				
51. Raw sewage Cl_2 evap.				
Cl_2 pressure				
Temperature				
52. Treated sewage Cl_2 evap.				
Cl_2 pressure				
Temperature				
53. Sulfur Dioxide evap.				
SO_2 pressure				
Temperature				
54. Raw sewage chlorinator				
Vacuum				
55. Treated sewage chlorinator				
Vacuum				
56. Sulfonator 1				
Vacuum				
57. Chem. feeder rm. exhaust fan 1				
58. " " " " " 2				
59. Chem. cont. rm. supply fan				
60. Fdr. rm. Cl_2 gas detector				
61. Stg. rm. Cl_2 gas detector				
62. " " SO_2 " "				
63. Stg. rm. exhaust fan				
64. Stg. rm. crane				
65. Chem. fdr. pump #1				
66. " " " #2				
67. Survivair unit				
68. Gallery tool board equip.				

OPERATOR

EFFICIENCY

SEC COD %	SEC SS %	SEC PO_4 %	SEC NH_3 %	SEC MPN %	TOTAL BOD %	TOTAL COD %	TOTAL SS %	TOTAL MPN %	REMARKS
75	76	77	78	79	80	81	82	83	

EATTLE

CONC.	AIR mcf/day	WASTE M.L. mgd	WASTE RAS mgd	lbs BOD/ 100lbs VS	lb BOD/ 1000 c.f.	SLUDGE AGE-JOD	c.f./100 lb BOD$_R$	lb $\frac{BOD_R}{100 lb VLVS}$	ECC SS ppm	FINAL SS ppm	% VOL	COD ppm	COD in solution	BOD ppm	O.D.-N ppm
47	48	49	50	51	52	53	54	55	56	57	58	59	70	71	72

MUNICIPALITY OF METRO POLITAN

RENTON TREATMENT PLA

AERATION

ppm	% VOL	MLVSS ppm	D N A ppm	D N A % VS	SETTLING	SVI		AERATION DET. TIME	D O PROBE	D O SET POINT	GATES OPEN	NO.	NO.	NO.	RAS mgd
31	32	33	34		36	37	38	39	40	41	42	43	44	45	